Comparative study of planetary magnetospheres

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In the solar system, structure and dynamics of planetary magnetospheres are affected by interaction with the solar wind with interplanetary magnetic field (IMF). Moreover, the individualities of planetary magnetospheres are determined by the mass, intrinsic magnetic field, co-rotation period and plasma sources. Thus three important parameters for planetary magnetospheres can be presented as the magnetopause distance, Alfven radius, where rotational speed equals the Alfven speed, and distribution and species of plasma sources. Moreover, many characters of planet such as atmosphere and ionosphere are strongly affected by distance from the sun. Therefore, we have studied structure and dynamics of the planetary magnetospheres with intrinsic magnetic field, in particular for Jupiter, hot Jupiter and Saturn by 3-dimensional global MHD simulation of interaction between the solar wind and magnetospheres and compared with the earth's magnetosphere.

Since Jupiter has the largest mass and large intrinsic magnetic field, shortest co-rotation period and a large amount of plasma source from moon, Io, the largest magnetosphere with magnetic disc is formed among planets of the solar system. Saturn is the second largest planet with short co-rotation period. However, the Saturn's magnetosphere may resemble the earth's one because the effect of intrinsic magnetic field is comparable with earth. Then since the IMF By component is generally strong by the Parker spiral, it was considered that auroras could be affected by the dynamic pressure of solar wind but less by the IMF. However, it has been pointed out that the magnitude and orientation of IMF can also have an important role on the aurora activity in Saturn as well as Jupiter. We will demonstrate the structure and dynamics of planetary magnetospheres of Jupiter, hot Jupiter and Saturn and compare them with those of earth in base of global MHD simulation results. We found clear formation of large vortices in the Saturn's magnetosphere, which comes from velocity shear of the solar wind and co-rotational plasma. It is not remarkable to excite large vortices in the magnetospheres of Jupiter and earth.